WEIGHT MEMBER FOR A GOLF CLUB HEAD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a weight member. In particular, the present invention relates to a weight member for a golf club head.

2. Description of Related Art

A conventional weight member for a golf club head is made by powder metallurgy in which metal powders of high density and high rigidity such as tungsten having a density of 19.30g/cm^3, iron having a density of 7.8g/cm^3, and nickel having a density of 8.9g/cm^3 are pressed and formed and then sintered to form a WFeNi alloy that forms the weight member for a golf club head. Although the powder metallurgy is widely used, several disadvantages exist, including: high cost for molds, low stretchability of products, long processing time, aptness to thermal expansion/shrinkage, and difficulty in forming delicate patterns, letters, serial number, trade names, etc.

Another method for manufacturing a weight member made of WFeNi alloy includes a precision casting process in which a specific metal melting sequence and a specific composition ratio are utilized to prevent sedimentation of tungsten having a high melting point. In the precision casting process, nickel of 30%-50%, iron of 30%-50%, tungsten of 20%-35%, silicon of less than 1%, manganese of less than 1%, and niobium of less than 0.5% are fed into a high-temperature furnace at a temperature above 1450℃ and melt to form a weight

weight member made of WFeNi alloy for a golf club head. The weight member is then embedded or welded to a golf club head body that is generally made of stainless steel, such as stainless steel of SUS304, 17-4, and 4130 series.

This precision casting process overcomes the problems of the above conventional powder metallurgy. However, as illustrated in Figs. 1 and 2 of the drawings, if the mixture ratio of the nickel, iron, and tungsten was not properly controlled, a pearlite structure was precipitated in a base of a γ (iron, nickel) phase of the WFeNi alloy, deteriorating the rust-resisting property of the weight member. Further, cracks were apt to be generated while welding the weight member to the golf club head body. The upper portion above a horizontal welding line in Fig. 1 of the drawings shows the weight member made of WFeNi alloy and the cracks generated during welding. Fig. 2 is an enlarged view of the pearlite structure and the cracks. When the pearlite structure was precipitated from the γ (iron, nickel) phase, the cracks were usually generated in the pearlite structure. During spray testing at 40℃ for 24 hours (which simulates a highly corrosive environment) to the WFeNi alloy by using NaCl solution of 5% by weight, the rusted area of the WFeNi alloy often exceeded 8% of the overall surface area of the WFeNi alloy. Further, as illustrated in Fig. 3, since tungsten was often precipitated on the surface of the WFeNi alloy (the deep color portion is the pearlite structure and the white portion surrounded by the pearlite structure is the precipitated tungsten), the tungsten/ γ (iron, nickel) phase formed by the alloy caused patterns on the

weight member made of WFeNi alloy after grinding and polishing procedures. As a result, an obvious insertion line was generated when the weight member made of WFeNi alloy was directly embedded into a bottom surface of a golf club head body. Further, the insertion line of the products varied in response to the thickness ground off, the angle of grinding. Thus, it is difficult to control the processing conditions.

OBJECTS OF THE INVENTION

An object of the present invention is to provide a weight member for a golf club head, wherein molybdenum is added during the precision casting process to reduce the cracks while welding the weight member made of WFeNi alloy to a golf club head body, thereby improving the welding property of the weight member.

Another object of the present invention is to provide a weight member for a golf club head, wherein chromium is added during the precision casting process to prevent the pearlite structure from being precipitated in the γ (iron, nickel) phase of the WFeNi alloy that forms the weight member, thereby improving the rust-resisting property of the weight member.

A further object of the present invention is to provide a weight member for a golf club head, wherein the mixture ratio of nickel to tungsten is controlled during the precision casting process to prevent the pearlite structure from being precipitated in the γ (iron, nickel) phase of the WFeNi alloy that forms the weight member, thereby increasing the good-quality products index

when the weight member is directly mounted to a surface of a golf club head body. The uniformity of the shining finishing, the appearance, and the assembling tolerance of the weight member are improved.

Still another object of the present invention is to provide a weight member for a golf club head, wherein silicon is added during the precision casting process to prevent poor flowability of the poured molten metal, thereby improving the efficiency of the process.

Yet another object of the present invention is to provide a weight member for a golf club head, wherein manganese, copper, vanadium, and niobium are added during the precision casting process to increase the flowability of the poured molten metal and to assist in removal of gas, thereby improving the mechanical strength of the weight member.

SUMMARY OF THE INVENTION

To achieve the aforementioned objects, the present invention provides a weight member for a golf club head that is made of a WFeNi alloy by a precision casting process. The WFeNi alloy includes wt 15%-40% of iron, wt 30%-60% of nickel, wt 15%-30% of tungsten, wt 1.5%-10.0% of chromium, and wt 0.5%-5.0% of molybdenum. Chromium improves the rust-resisting property of the weight member. Molybdenum reduces the risk of cracks in the weight member during a subsequent welding procedure for welding the weight member to a golf club head body. Uniformity of shining finishing of the weight member can be improved by means of controlling a mixture ratio of nickel to

tungsten. Appropriate amounts of manganese, copper, vanadium, and niobium may be added to improve the mechanical properties of the weight member.

Other objects, advantages and novel features of this invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a microphoto showing a pearlite structure and cracks generated during welding of a conventional weight member of WFeNi alloy to a golf club head body;

Fig. 2 is an enlarged view of a portion of the pearlite structure and cracks in Fig. 1;

Fig 3 is a microphoto showing a pearlite structure and tungsten precipitated from a conventional WFeNi alloy made weight member for a golf club head;

Fig. 4 is a microphoto of a WFeNi alloy made weight member for a golf club head in accordance with the present invention, wherein the WFeNi alloy includes chromium;

Fig. 5 is a solidus curve of tungsten precipitated from the γ (iron, nickel) phase of WFeNi alloy that forms the weight member for a golf club head in accordance with the present invention; and

Fig 6 is a microphoto showing the WFeNi alloy that forms the weight member for a golf club head in accordance with the present invention, wherein

the WFeNi alloy includes chromium and molybdenum.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention is now to be described hereinafter in detail

Fig. 4 is a microphoto of a WFeNi alloy made weight member for a golf club head in accordance with the present invention, wherein the WFeNi alloy includes chromium. Fig. 5 is a solidus curve of tungsten precipitated from the γ (iron, nickel) phase of WFeNi alloy that forms the weight member for the golf club head in accordance with the present invention. Fig 6 is a microphoto showing the WFeNi alloy that forms the weight member for the golf club head in accordance with the present invention, wherein the WFeNi alloy includes chromium and molybdenum.

Most procedures of the method for manufacturing the weight member for a golf club head in accordance with the present invention are identical to those of the precision casting process mentioned in the background of the invention and therefore not described again to avoid redundancy.

The weight member for a golf club head in accordance with the present invention is preferably manufactured by means of precision casting process. In the precision casting process, metals are fed into a high-temperature furnace at a temperature between 1450℃ and 1750℃ (preferably 1660℃-1680℃), and chromium is added while controlling the mixture ratio of nickel to tungsten, thereby forming a molten WFeNi alloy. Next, the molten WFeNi alloy is

poured into a preheated mold with a specific shape, precise patterns, and letters. The preheating temperature for the mold is set between 950℃ and 1300℃. Thus, a weight member for a golf club head is made by precision casting process. The weight member is then engaged (by, e.g., embedding, welding, etc.) to a golf club head body made of stainless steel, such as stainless steel of SUS304, 17-4, and 4130 series.

According to the present invention, in the precision casting process, nickel particles, pure iron, tungsten iron, silicon iron, and chromium are added into a high-temperature furnace. The nickel particles and the pure iron melt first to form an alloy that reduces the melting point of the tungsten iron. Thus, the tungsten iron having a high melting point melts in the furnace without causing sedimentation of tungsten. Next, appropriate sampling test and control are proceeded to form molten WFeNi alloy comprising wt 15%-40% of iron, wt 30%-60% of nickel, wt 15%-30% of tungsten, and wt below 1.5% of molybdenum, and wt 1.5%-10.0% of chromium.

Referring to Fig. 4, when manufacturing the alloy, chromium of 1.5%-10% by weight is added to avoid precipitation of pearlite structure from the γ (iron, nickel) phase of the WFeNi alloy that forms the weight member, thereby improving the rust-resisting property. During spray testing at 40℃ for 24 hours (which simulates a highly corrosive environment) to the WFeNi alloy by using NaCl solution of 5% by weight, the rusted area of the WFeNi alloy is merely 1% of the overall surface area of the WFeNi alloy.

Still referring to Fig. 4, if chromium of 1.5%-10% by weight is added, generation of the pearlite structure is depressed, which allows the WFeNi alloy to increase the rust-resisting property thereof and to pass the spray testing. Nevertheless, as illustrated by the crystalline phase shown in Fig. 4, carbonide is precipitated on the crystal boundary of in the base of the γ (iron, nickel) phase. As a result, cracks are generated during welding of he WFeNi alloy. Referring to Fig. 5, during manufacture of the alloy, the mixture ratio of tungsten to nickel is controlled. When an alloy with patterns and stain finishing is required, the mixture ratio of nickel to tungsten is maintained above the solidus curve of the γ (iron, nickel) phase. When an alloy with a shining or mirror finishing is required, the mixture ratio of nickel to tungsten is maintained below the solidus curve of the γ (iron, nickel) phase. Thus, the tungsten can completely solve as a solid solution in the nickel of a sufficient amount. The solidus curve of nickel and tungsten satisfies the following equation:

$$Y = 1.26X - 38.99\%$$

wherein Y is the percentage of tungsten by weight, and Y is not less than X. For example, if nickel in the alloy is 51.78%, the nickel amount is sufficient to solidly solve tungsten of 19.6%. On the other hand, if nickel in the alloy is 55%, the nickel amount is sufficient to solidly solve tungsten of 30.3%. Thus, precipitation of tungsten in the γ (iron, nickel) phase of the WFeNi alloy made weight member, which prevents generation of patterns on the surface of the

WFeNi alloy. Since the surface of the weight member may provide improved shining finishing uniformity, the insertion line between the weight member and the golf club head body can hardly be seen when the weight member is directly engaged to (particularly by embedding) the surface of the golf club head body and then polished. Thus, the engaging difference between individual golf club head body and the weight member can be avoided, and the processing conditions can be controlled to be the same. Accordingly, the added value and the engaging/assembling tolerance of the weight member are increased.

Further, the flowability during casting can be improved by means of adding silicon less than 1.5%.

As illustrated in Fig. 6, after the above metals are added into the high-temperature furnace, molybdenum of an appropriate amount is added. Addition of molybdenum of 0.5%-5.0% causes precipitation of uniformly distributed carbonide from the γ (iron, nickel) phase of the WFeNi alloy that forms the weight member, thereby preventing generation of cracks while welding the WFeNi alloy made weight member to a golf club head body. Thus, the weight member can be welded to the golf club head body by, e.g., laser welding or argon welding.

Further, an appropriate amount of manganese iron, copper, vanadium iron, and niobium iron can be optionally added. The mechanical properties of the weight member, the flowability during casing, and removal of gas are improved when at least one of Mn of less than 1.0%, Cu of less than 4.0%, V of

less than 1.0%, and Nb of less than 1.0% is added.

Further, the density of the WFeNi alloy made weight member for a golf club head in accordance with the present invention can be selected according to different uses of different golf club heads. Preferably, the density of the weight member is 9.0g/cm^3-10.5g/cm^3, and the melting point of the weight member is 1400℃-1500℃ (2552°F-2732°F), preferably 1455℃ (2651°F).

The nickel particles, pure iron, chromium, and molybdenum mentioned above mean pure metal (including small amount of impurities) of nickel, iron, chromium, and molybdenum, respectively. The tungsten iron, silicon iron, manganese iron, vanadium iron, and niobium iron mean ferroalloy of tungsten, silicon, manganese, vanadium, and niobium, respectively. During the precision casting, the amount of tungsten, silicon, manganese, vanadium, and niobium are so adjusted based on the contents of the tungsten iron, silicon iron, manganese iron, vanadium, iron, and niobium iron that the molten alloy of WFeNi satisfies the above-mentioned proportion for making the weight member. Further, the WFeNi alloy may contain trace elements such as carbon of less than 0.1%, sulfur of less than 0.1%, and phosphorus of less than 0.1%.

According to the above, the disadvantages of the weight member made by the conventional precision casting process are obviated and/or mitigated by the precision casting process in accordance with the present invention. The physical/chemical properties of the weight member are improved by means of adding chromium and molybdenum as well as controlling the mixture ratio of

nickel to tungsten. The rust-resisting property, uniformity of the shining finishing, appearance, and the assembling tolerance of the weight member are improved while allowing the weight member to be welded to a golf club head body without generation of cracks.

While the principles of this invention have been disclosed in connection with its specific embodiment, it should be understood by those skilled in the art that these descriptions are not intended to limit the scope of the invention, and that any modification and variation without departing the spirit of the invention is intended to be covered by the scope of this invention defined only by the appended claims.